Equine Infectious Anemia, or Swamp Fever

BY C. D. STEIN [1]

HUMAN BEINGS have their malaria and horses their swamp fever, but the latter is the more difficult to diagnose and treat. The horse disease is widespread, persistent, and debilitating, and the virus has been known to remain active in an animal for many years. The author suggests practical ways to minimize the damage.

INFECTIOUS ANEMIA, or swamp fever, also known in some sections of the United States as malarial fever, slow fever, and mountain fever, is one of the most serious maladies of the horse, and because of its insidious nature and widespread distribution it has become a problem of world-wide concern.

Infectious anemia is an acute or chronic disease of equines, caused by a filtrable virus that poisons the blood and characterized principally by intermittent fever, marked depression, progressive weakness, loss of weight, edema (dropsylike swelling), congestion and icterus (jaundice) of the visible mucous membranes, and anemia of a transitory or progressive type.

Long recognized as a specific infectious disease of equines, infectious anemia was reported from Europe as early as 1843. It occurs in various parts of Europe, Asia, Africa, and North America (9).[2] Recently the disease has been reported from Venezuela, South America. The disease has existed in the United States for at least 50 years, and since 1900 has been authentically reported in isolated areas from 29 States. In 15 of these States the virus was recovered by horse-inoculation tests, while diagnosis in the other 14 States was based on clinical examination. Since 1932, outbreaks of the disease have been

reported from Maryland, Massachusetts, Mississippi, New York, Indiana, Illinois, Michigan, Kansas, Wyoming, Montana, Colorado, Oregon, Idaho, Texas, Virginia, Vermont, and Washington. Since 1935 investigators in the Bureau of Animal Industry have isolated the virus from field cases in New York, Maryland, Virginia, Mississippi, Louisiana, Pennsylvania, California, Texas, and Wyoming.

Because of the difficulty of diagnosis, the disease is probably more widespread than the reports indicate. Generally speaking, it is most prevalent in poorly drained, low-lying sections, but it has been found in wooded sections and on marshy pastures at high altitudes. It also appears to be more prevalent when biting insects are most numerous and during wet years. The disease appears in the active form in May or June and reaches its height in midsummer, usually declining late in the fall. Chronic cases may be seen at all seasons of the year, and it is possible to produce the disease experimentally at any time.

Except in the Mississippi Delta, the disease occurs in the United States mostly as a sporadic infection, isolated cases or outbreaks for the most part being reported from and confined to low-lying and wooded sections in the States where it is known to exist. In the Mississippi Delta the disease has become established among the mules on the large cotton plantations and is of considerable economic importance; occurring principally in the chronic form, it saps the strength of the animals and renders them incapable of regular work in the busy cotton-growing season when they are most needed (5).

CAUSE

Studies and observations of the disease made by Bureau of Animal Industry investigators in the field and under experimental conditions indicate that debilitating influences that lower the resistance of an animal, such as overexertion, extreme heat, high humidity, faulty nutrition, improper care and handling, bad sanitation, impure water supply, and a heavy infestation of intestinal parasites, are not only predisposing factors but also have a marked influence on the progress of the disease in infected animals. Gates (5) in 1939, reporting on the disease in Mississippi, made similar observations.

Although the infectious nature of the disease was known as early as 1859, the causative agent was not definitely established until 1904, when Carre and Vallee (2) demonstrated that it was a filtrable virus. This finding was confirmed by the early investigations of the Bureau and has since been repeatedly substantiated.

Under natural conditions the virus appears to be specific for equines (the horse, mule, and donkey). It may persist in the host for years. It is apparently present in the blood and body tissues of affected animals at all times and may be eliminated with some of the secretions or excretions. The disease can be readily transmitted experimentally to equines by inoculation, beneath the skin or into the blood stream, of whole blood, blood serum, or spleen, brain, or other tissue emulsions. Experiments and transmission tests made by the Bureau with strains of virus isolated from widely separated areas indicate that

its virulence is exceedingly variable and appears to be influenced by a number of factors. Among these are the individual susceptibility of the host, frequency of passage—that is, transmission of the disease from one animal to another (in series) at short intervals—method of exposure, source of virus, character of the inoculating substance (inoculum), and debilitating factors affecting the host.

The virus shows considerable resistance against disinfectants, heating, freezing, and drying. Definite findings of Bureau investigators concerning the action of heat and chemicals on the virus have been put into practical use in formulating requirements for the treatment of antiserums prepared from horses, thus safeguarding against dissemination of swamp fever through the use of such biological products. Biological supply houses operating under Government license are now required to heat all antiserums prepared from horses at 58° to 59° C. (136.4° to 138.2° F.) for an hour, which destroys any infectious anemia virus they may contain.

DISSEMINATION AND TRANSMISSION

While dissemination of the disease usually follows the introduction of infected animals into noninfected territory, the common method of transmission in the natural state is not definitely known. Ordinarily the disease appears to spread slowly. During the transportation of great numbers of horses, however, outbreaks may occur when infected animals are moved into new territory where conditions are favorable for transmission and for the exposure of large numbers of normal horses.

A number of investigators who have worked on this problem are of the opinion that the disease is spread principally in pastures where the virus-laden urine and feces of infected animals contaminate the feed and water, but the part that biting insects may play under these conditions cannot be ignored.

Experimental evidence indicates: (1) That the disease is readily transmitted by the injection of blood or tissue emulsions from affected animals into susceptible ones; (2) that minute doses of the virus are infective for susceptible animals; (3) that the body secretions or excretions may contain the virus; (4) that infected mares may transmit the disease to their offspring; (5) that the disease may be transmitted by external parasites, including biting flies and biting lice; (6) that it may spread slowly by long, continuous, intimate contact; and (7) that carriers probably constitute one of the most common sources of the virus in nature and are chiefly concerned in the perpetuation of the disease. In adopting control measures, these factors should all be taken into consideration.

Infectious anemia has been reported in man in a few instances, but it is probable that man is not very susceptible to the disease. Verge (*10*) in 1933 reported the occurrence of two cases in human beings, those of Luhrs in 1920 and Peters in 1924. In the experiments conducted by the Bureau, equines only were found to be susceptible. Attempts to infect calves, sheep, swine, dogs, rabbits, guinea pigs, rats, mice. and pigeons were without success. Similar results have

been obtained by various workers (*4*)   Some investigators in foreign countries, however, have reported that a few other species, including young goats, pigs, rabbits, rats, chickens, and doves, can be infected under experimental conditions.

Mules appear to be somewhat more resistant than horses, acquiring the disease mostly in the chronic form. Balozet (*1*), in 1933, reported from Tunis, North Africa, that the African ass was as susceptible to the virus of infectious anemia as the horse but that the symptoms were more apparent in the horse. DeKock (*3*) reported a natural outbreak of infectious anemia in donkeys in Natal, South Africa, that assumed a rather virulent character.

FORMS OF THE DISEASE, SYMPTOMS, AND TERMINATION

The clinical symptoms are variable and depend to a great extent on the form the disease assumes. Infectious anemia may occur as an acute, rapidly fatal disease or, more commonly, as a chronic affection characterized by intermittent attacks of fever, loss of weight, progressive weakness, marked depression, and dropsical swellings on the lower portions of the body and on the legs. The disease may also exist in a form in which no clinical symptoms are apparent though the affected animal carries virulent virus in the blood stream.

In the acute form of the disease the incubation period following subcutaneous injection (beneath the skin) of infected blood is usually about 12 to 15 days, though it may vary from less than a week to 3 months and possibly longer. The onset is sudden and is manifested by a rise in temperature, which usually goes to about 105° F. but may reach 108°. In the acute form the febrile attacks are usually severe and may be more or less continuous or very frequent. In this connection it should be mentioned that the irregular recurrent fever is one of the chief clinical manifestations of the disease, and in mild cases it sometimes constitutes the only symptom. Respiration is accelerated and frequently is of the abdominal type. The animal is dejected, the head hangs low, leg weakness is marked, the body weight is shifted from one leg to another, and the hind feet are frequently placed well forward under the body. The membranes of the eyes show congestion, followed by brownish to yellowish discoloration. Feed is refused. There may be a slight watery discharge from the eyes and nose and, if the weather is extremely warm, profuse sweating. Frequent urination may also be noted, and in severe cases diarrhea may develop. The attack usually lasts from 3 to 5 days, after which the temperature returns to normal and the animal appears to be well except for a marked loss of weight. Occasionally, however, the initial attack may persist until the animal dies.

Dropsical swellings of the sheath, the legs, the chest, and the under surfaces of the body may occur at any time. These frequently disappear and appear again at the same or other places. Subsequent attacks usually follow, with intervening periods of normality varying from a few days to many weeks or months. When the intervals

between the attacks of fever are short, the animal seldom lives more than 15 to 30 days. During the attacks of fever and immediately afterward, there is a reduction in the number of red corpuscles in the blood. When this is pronounced, it can be readily demonstrated by drawing some blood into a test tube in the bottom of which a small amount of powdered potassium oxalate or other anticoagulant has been placed to prevent clotting. During the bleeding process the tube should be agitated gently to mix the blood with the anticoagulant. The tube containing the blood sample should be placed in an upright position to permit the red corpuscles to gravitate to the bottom, and after half an hour a comparison of the sedimented red corpuscles with a sample similarly drawn from a normal horse will clearly demonstrate the degree of anemia that exists. During the periods of normality between attacks, the red-corpuscle count is in a great majority of cases normal.

The subacute and chronic forms of the disease differ from the acute in that the attacks are less severe and the intervals between them are longer. The subacute cases may terminate in death during or following one of the attacks, or the reactions may grow less frequent, the animal finally developing into a chronic case or a clinically recovered carrier. In general, the chronic form is manifested by unthriftiness, rough coat, underweight; sluggishness, weakness, dropsical swellings of the lower parts of the body or on the legs, muddy discoloration of the visible mucous membranes, and small hemorrhages on the nictitating membrane (the third eyelid, or haw) and the nasal septum (the partition between the passages of the nose).

As the disease progresses, evidence of anemia may develop, the red-corpuscle count may be extremely low, the blood may appear thin and watery, and in the later stages the visible mucous membranes may become pallid. The pulse may be slow and weak, the heart action may become irregular, and a jugular pulse may be visible. There may be a rapid slowing of the pulse after exercise. Muscular weakness is manifested by a wobbly or rolling staggering gait or by partial paralysis of the hindquarters. In the chronic form of the disease the appetite is for the most part unimpaired and frequently is ravenous, so that the animals may eat continuously if they have access to feed. In spite of the excessive consumption of feed, however, there is a progressive loss of body weight (fig. 1).

Animals affected with this form of the disease can perform some work if handled with care. They are subject, however, to recurring attacks characterized by extreme weakness, knuckling, inability to walk in a straight line, and prominent hemorrhages on the third eyelid. The weakness may become so great that the animal cannot stand without support. With good attention, rest, and supportive treatment, it usually overcomes these periodic attacks and may go back to routine work. Each attack takes its toll of flesh and strength, however, and repetitions, if frequent enough, will so weaken the animal as to render it useless or finally bring about death by exhaustion.

The inactive or latent form of the disease may follow the initial attack, but it is usually preceded by several attacks of fever. This

form is observed in animals that have apparently recovered from the acute, subacute, or chronic types of the disease. Animals affected with the disease in the latent form show no clinical symptoms and are known as clinically recovered carriers. The temperature remains normal, and there is no reduction in the red corpuscles or any sign of disease over a period of years, and yet the infectious agent is always present in the blood stream and all the tissues and may be eliminated with the body excretions. Such animals obviously are a menace to other horses that may be near them, since they are veritable reservoirs of infection that for the most part go
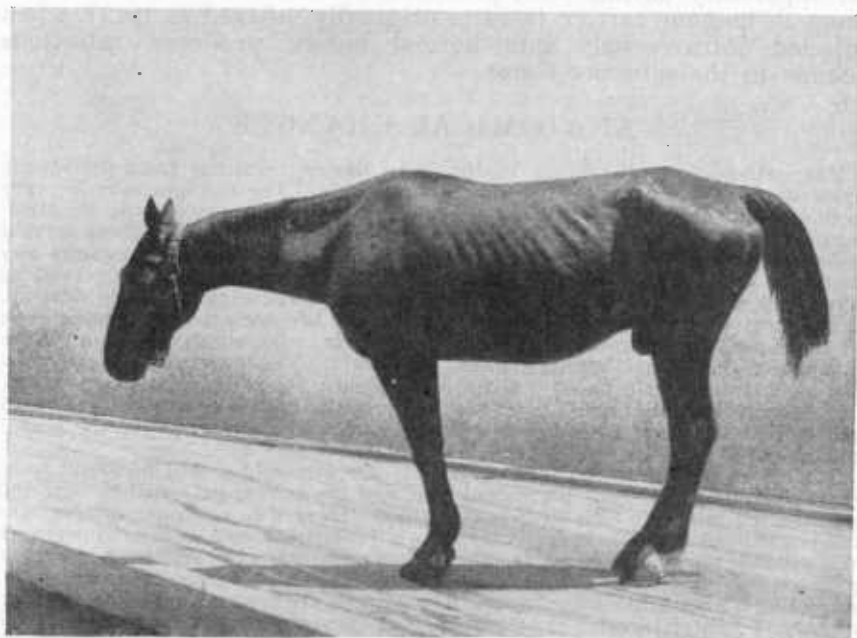

FIGURE 1.—The poor condition of this horse is the result of infectious anemia in the chronic form.

unrecognized and uncontrolled. The inactive form of the disease may, however, become active at any time and present all the characteristics of the acute or subacute form. Unusually hard work or any debilitating influence may reactivate the infection.

The Bureau of Animal Industry has under observation a horse that is a good example of the inactive form of infectious anemia. This horse was exposed to the disease August 2, 1935, by being given an injection of filtered blood from two horses known to have infectious anemia. After an incubation period of 12 days, a typical attack of fever occurred, which in turn was followed by two more attacks within a 3-week period. No further attacks occurred over a period of approximately 5 years. During this time the animal remained in good physical condition and showed no symptoms of

disease whatever; yet blood drawn from it at intervals during the 5 years produced infectious anemia when injected into normal horses. A horse with a similar history that has been infected for approximately 6 years is also being held under observation; although this animal has shown no clinical symptoms for more than 6 years its blood remains infectious.

Schalk and Roderick (*7*), of the North Dakota Agricultural Experiment Station, and Scott (*8*), of the Wyoming station, have reported inactive cases that were infectious over even longer periods.

Heath (*6*) in 1931, reporting on transmission experiments carried on apparently during 1930, presented evidence to show that blood from an immune carrier (a mare originally infected in 1912), when injected intravenously into normal horses, produced infectious anemia in the subacute form.

ANATOMICAL CHANGES

The pathological alterations in the body tissues resulting from artificially induced infectious anemia are extremely variable. The changes may be very well marked and plainly visible (in some cases so pronounced as to be striking), or they may be so slight as to escape detection except by those having considerable experience with the disease. The lesions, which may occur in any degree of intensity or in any combination, are most commonly observed in acute and subacute cases and in chronic cases dying during an acute flare-up.

The most constant lesions of swamp fever are hemorrhages of varying sizes on the serous and mucous membranes of the body, with enlargement and other changes of the spleen, kidneys, liver, and heart. The hemorrhages are most frequently found on the parietal and visceral pleura, the pericardium, epicardium, and endocardium, the parietal and visceral peritoneum, the mucosa of the small and large intestines, the mucosa of the caecum, and the surface of the spleen and kidneys.

The spleen for the most part is enlarged. Occasionally it will be found to be approximately three times its normal size, and the splenic pulp will be soft and blackish red in color. The liver is frequently enlarged to enormous proportions and is hard and friable. It may vary from a yellowish-brown, cooked appearance to a reddish brown. Frequently there is pigmentation of a yellowish-brown or greenish-gray tinge. In cross section the lobules stand out quite prominently, presenting a nutmeglike appearance. The kidneys are frequently enlarged, edematous, and lighter in color than normal, and they show numerous hemorrhages on the surface ranging from the size of a pin point to several millimeters in diameter. The heart may be enlarged, flabby, and lighter in color than normal, or it may have a cooked appearance, and it shows hemorrhages over the epicardium, in the myocardium, and on the endocardium. The heart fat frequently loses its normal consistency and color and becomes soft and gelatinous. The visceral lymph glands are usually enlarged and edematous and may be impregnated with hemorrhages. Large areas of hemorrhages are found in the marrow of the long bones, especially of the femur. Yellowish discoloration of the connective tissues and fat may also be evident. As stated before, the lesions are quite variable.

In those subacute or chronic cases showing clinical manifestations of a progressive anemia, the autopsy may also show pale mucous membranes and light-colored, thin, watery blood.

For the most part the tissue changes found in the acute and subacute cases are more extensive and more pronounced than those in the chronic cases. In chronic cases terminating in death from exhaustion following a protracted illness, lesions indicative of cachexia (general ill health) are usually observed, such as emaciation, gelatinous infiltration of connective tissue and fat tissue, especially the fat tissue of the heart, and a blanched appearance of mucous membranes. In such cases the hemorrhagic infiltration of tissues and degenerative changes of the organs may be very slight or entirely absent.

In latent cases (symptomless carriers) and chronic cases of a mild type little or no anatomical alteration is observed on autopsy. The most constant and characteristic histopathological findings are round-cell infiltration and a heavy deposition of hemosiderin in the liver and spleen. The post mortem histological findings are of considerable assistance in making a tentative diagnosis.

DIAGNOSIS

Diagnosis of infectious anemia is usually a difficult matter, since there are no symptoms or post mortem changes that can be considered characteristic or peculiar to this disease alone. The only definite means of diagnosis is by horse-inoculation test. Considering collectively the history of the case, clinical symptoms, and blood examinations, diagnosis with a reasonable degree of accuracy can possibly be made in the active form of the disease. For example, a history of rapid loss of flesh, loss of spirit and energy, evidences of muscular weakness with intermittent attacks of fever, congestion of the mucous membranes of the eye, with possibly some degree of jaundice, and dropsical swellings of the lower parts of the body, collectively, are strongly suggestive of infectious anemia. The tentative diagnosis will be further strengthened if during and immediately after the febrile period an examination of the blood shows a diminution in the volume of the red corpuscles, an increase in the rate at which they gravitate, and a decrease of hemoglobin. It must be remembered, however, that in the intervals between the attacks of fever the blood picture, except in cases accompanied by a progressive anemia, usually returns to normal.

Infectious anemia in the inactive form would ordinarily not be detected, since no clinical symptoms would be present to cause suspicion. It should be remembered also that heavy infestation with intestinal parasites, especially strongyles, produces symptoms that are in some respects similar to those of infectious anemia. Microscopic examinations of the feces for the eggs of these parasites and examination of blood films for evidence of eosinophilia (an increase in the number of certain white blood corpuscles) will assist in making a differential diagnosis. It is possible, and in some areas probable, that some horses and mules will be heavily infested with intestinal parasites and at the same time have chronic infectious anemia.

In acute cases occurring in the field, death may occur before the usual train of symptoms develops. The disease in the acute form may be confused with anthrax, influenza, purpura hemorrhagica, acute equine encephalomyelitis, and other acute febrile conditions. In the subacute and chronic forms it may be mistaken for trypanosomiasis (dourine, murrina, and surra) or strongylidosis.

Since the development of practical and reliable means of diagnosis is of primary importance from the standpoint of control, a considerable amount of experimental work on diagnostic procedures has been carried out by the Bureau of Animal Industry. No laboratory blood test was found sufficiently satisfactory to warrant its adoption as a standard diagnostic method, and antigens prepared from the blood, tissues, and urine of affected animals failed to produce a specific response of diagnostic value.

TREATMENT AND CONTROL

Many investigators have unsuccessfully tried to treat the disease with various agents such as arsenic preparations, quinine, various dyes, mercurial preparations, and a number of others. In sections where the disease is endemic, or constantly present, practicing veterinarians employ supportive treatment, using arsenical compounds, principally sodium cacodylate, together with tonics, rest, and abundance of good feed, at the same time eliminating intestinal parasites and other debilitating factors. While such treatment brings about some clinical improvement, it has no lasting value, for the animal remains infected, is subject to febrile attacks, and is a virus carrier. To establish a complete cure, a method of treatment must be found that will not only free the animal of clinical symptoms but completely eliminate the virus from the tissues.

The control of this disease, because of its obscure nature, the difficulty of diagnosis, its resistance to treatment, and its widespread distribution, presents a problem of serious concern to all owners of horses and mules, especially those with a large number of animals.

Preventive vaccination has been attempted without success by a number of investigators, including those in the Bureau of Animal Industry.

The control of infectious anemia depends primarily on the identification of the chronic carriers. While no systematic program can be undertaken until a definite and practical means of diagnosis of chronic carriers is developed, the results of studies by Bureau and other investigators indicate that the following measures constitute the most effective means of control.

When a definite diagnosis of infectious anemia has been made, it is advisable, if practicable, to kill the animal and dispose of the carcass by cremation or deep burial to prevent further spread of the infection. This method of control has been followed in small isolated outbreaks and in establishments keeping large numbers of horses, and it has been effective in preventing the spread of the disease. It is obvious, however, that the method is impracticable in such areas as the Mississippi Delta, where the disease is widely distributed and exists principally in a mild chronic form.

Animals known to be infected and those suspected of having the disease should be isolated from healthy animals.

The common use of equipment that may produce skin abrasions or absorb body excretions or secretions, such as bridles, harness, saddles, blankets, brushes, and currycombs, on both infected and healthy horses is dangerous and should be avoided.

The greatest care should always be used to prevent transmission of the disease from animal to animal by the use of unsterilized instruments, bleeding needles, or hypodermic needles.

Since infected mares may transmit the disease to their offspring, such animals should not be used for breeding purposes.

Infected and healthy animals should not be kept together in small, poorly drained paddocks adjacent to stables and manure dumps.

Where premises are badly contaminated, or a number of cases of

the disease have developed on certain pastures, it is advisable to move the animals to new quarters, deeply plow the ground, and fence off the infected areas. Horses or mules should not be permitted on such pastures or premises for at least 6 months.

The maintenance of good sanitary conditions, fly control, systematic control of intestinal parasites, and provision for a supply of pure, fresh drinking water should also receive attention, and under no circumstances should animals be permitted to drink from stagnant pools.

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